IS SUBOPTIMAL FLYING PERFORMANCE PREDICTABLE?

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Aberdeen Proving Ground, MD
21 May 2014

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Disclosure Information

- **The views expressed in this presentation are solely those of the authors and do not represent the opinions of the US Air Force or Booz Allen Hamilton. We have no financial relationships to disclose.**

Background

- Fatigue, G-induced loss of consciousness, hypoxia, spatial disorientation and cognitive overload have led to numerous mishaps in USAF aircraft
- In at least 25 cases since 2008, F-22 pilots have reported experiencing "hypoxia-like symptoms" in mid-air, according to the Air Force
- F-22 pilots have experienced unexplained symptoms of oxygen deprivation -- including confusion, sluggishness and disorientation
- Aircraft monitoring systems provide thousands of signals from the aircraft concerning system’s status but not one signal is currently provided about the pilot’s status

Project Objectives

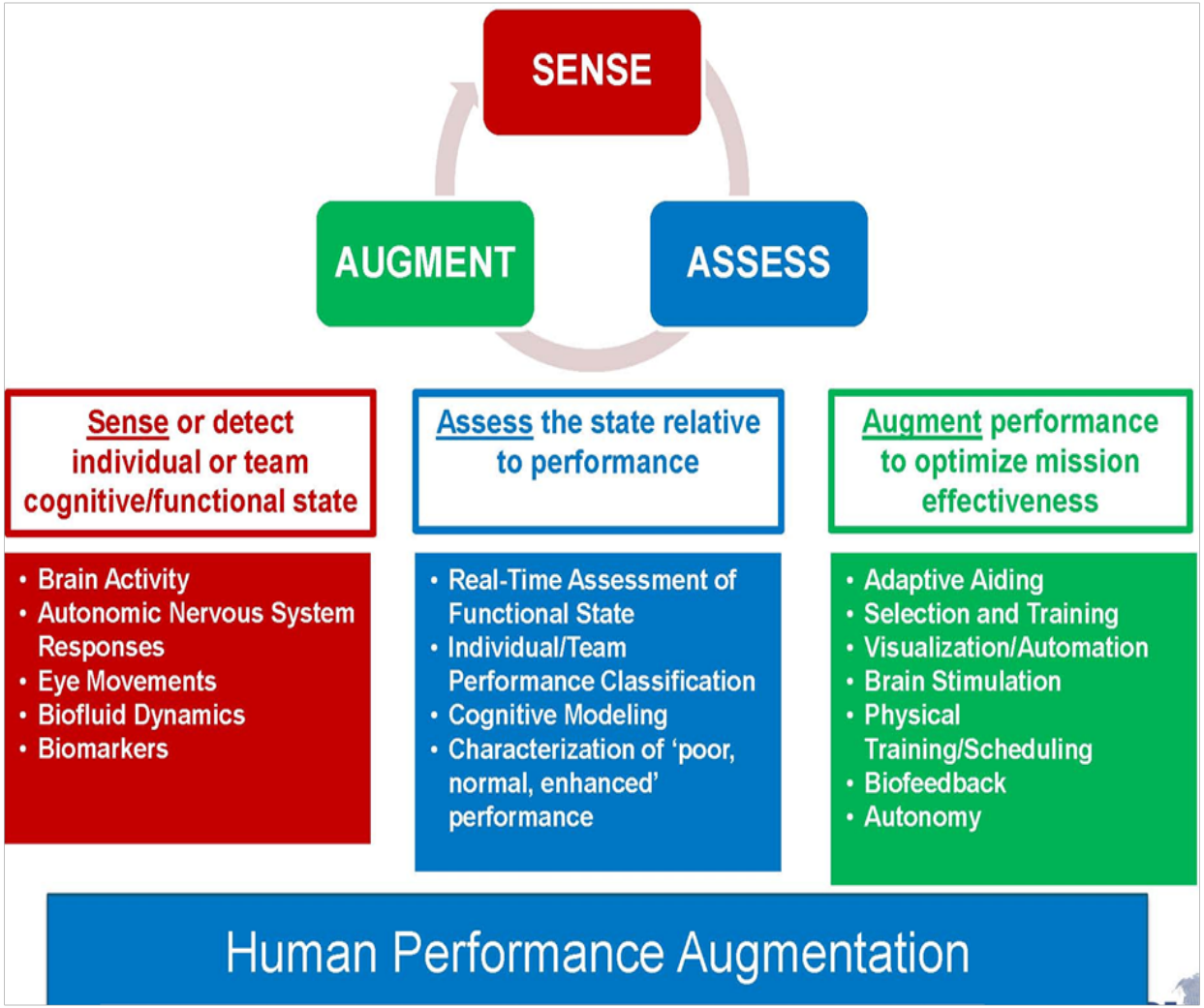
- Search for, review, analyze information on available and emerging physiologic sensor technologies with the long term goal of in-flight monitoring.
- In-flight monitoring would focus on physiologic and performance measures that are susceptible to stressors such as sleep loss, extended duty day and the specific physiologic conditions faced by pilots in cockpit/ground station environments.
- Produce catalog of available science and technology to measure human physiologic indications and predict performance outcomes to *enable real-time risk management decisions during military operations.*

Goal: determine real-time status of the operator's capability, as a way of predicting sub-optimal performance before it occurs or is seen behaviorally.

Activities

- Completed a review of the literature published in peer-reviewed scientific journals, DTIC's collection of military labs' technical reports, conference proceedings, white papers, academic textbooks, and in public circulation on human physiological and cognitive monitoring.
- Completed a review of technology and devices that can monitor human physiological and cognitive indications and predict performance outcomes
- Reported findings by availability, validity, cost, and Technology Readiness Level (TRL) (ASD(R&E) TRA guidance used for assessment of TRL).
- Documented all work in a final written report (Not released to the public as of Mar 2013)

Sense-Assess-Augment



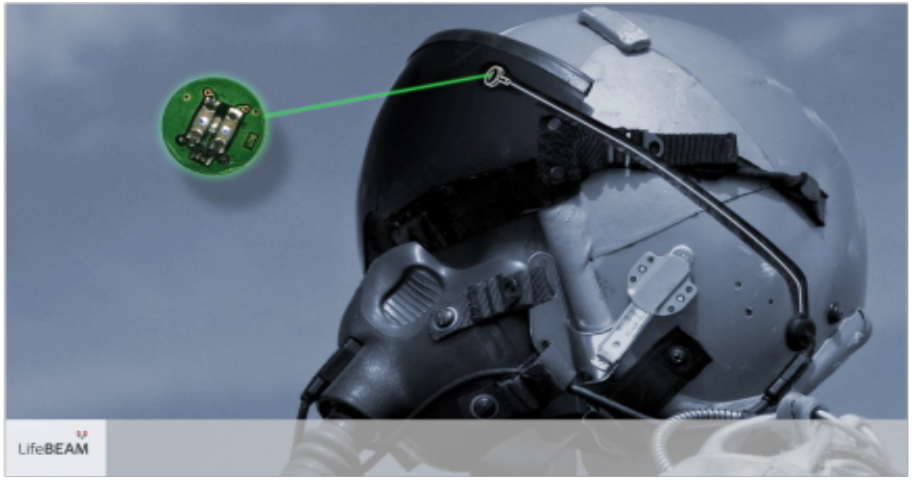
Helmet-mounted physiological sensing systems

- Sensors integrated into a flight helmet can monitor heart rate, blood flow perfusion, % oxygen saturation, cerebral oxygenation – current status of the pilot's physiology

- The 711 HPW at WPAFB, OH has developed an ear cup sensor that allows noninvasive physiological monitoring of F-22 pilots

Helmet-mounted physiological sensing systems

- LifeBeam uses an optical method to obtain volumetric blood changes in the pilot via their helmet-mounted system
- LifeBeam has tested their instrumented flight helmet in a centrifuge, altitude chamber, and in other tests at 711 HPW and NAMRU-D at WPAFB, OH



Breathing and saliva monitoring technologies

- **Volatile organic compounds (VOCs)** (Curt Grigsby 711 HPW) can be monitored to reveal the identity of a unique individual, as well their physiological status.
  - F-22 data being analyzed to determine a correlation between pilot's breath and fatigue, cognitive performance
- **Detection of Orexin A Neuropeptide** (Josh Hagen & 711/RHC)
  - Found in blood and saliva
  - Known to be an indicator of fatigue and cognitive performance

Eye Metrics Technologies

- Eye monitoring can be accomplished by affixing the device to the helmet or tracking eye metrics remotely such as at a UAS console or instrument panel
- Subtle changes in pupil position, pupil diameter and eyelid closure have been attributed to cognitive performance
- Eye metrics can be synchronized with other biometric devices to collect physiological measures such as EEG, EKG, and % Oxygen Saturation, in order to develop a more comprehensive picture of the pilot's cognitive status

Conclusions and Recommendations

- **Conclusions:**
  - Technologies and devices were discovered and subjectively assessed with a TRL of 6 or 7.
  - None of these has been integrated with the cockpit or had the concomitant validated software or performance models developed in tandem that would make them ready to integrate with the cockpit or UAS station and predict operator performance.
- **Recommendations**:
  - **<u>Develop operator performance algorithms and software models</u>**
  - Develop and refine human performance models
  - Bottom Line: Suboptimal flying isn't predictable with today's technology but will be in the near future